Converging Voice and Data over Mission-Critical Networks

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Abstract

The U.S. National Aeronautics and Space Administration (NASA) Deep Space Network - or DSN - is an international network of antennas that supports interplanetary spacecraft missions and radio and radar astronomy observations for the exploration of the solar system and the universe. The network also supports selected Earth-orbiting missions. This paper describes the ground communications network of the DSN and ways network infrastructure costs are being reduced by the introduction of new technology.

Fundamentally, the DSN ground network architecture is a star network, and the hub is at JPL in Pasadena, California. Communications to customer sites are designed to minimize NASA costs and may be either shared IP backbone networks or dedicated circuits. One of the primary features of the network is its ability to support real-time data, voice, and video communications among antenna stations, an automated multi-mission operations systems facility at JPL (AMMOS), and mission operations centers (MOCs) at NASA and non-NASA facilities.

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Key words: Ground communications, networks, Internet, communications, voice, VOIP.

Background

The DSN has three major antenna sites: 1) Canberra, Australia, 2) Goldstone, California, and 3) Madrid, Spain. They are supported with two primary circuits (T1). The primary circuits are channelized into flight network Internet Protocol (IP) bandwidth, legacy voice and video channels, and administrative IP bandwidth. IP bandwidth is aggregated by using multilink point-to-point protocol (MLPPP) over the IP channels in the two circuits.

The flight IP channels are used for transmitting the following:

- Spacecraft telemetry.
- Spacecraft command.
- Spacecraft tracking data.
- Station monitor and control data.

Data to mission operation centers is forwarded world wide. At the present time in addition to domestic centers, this includes Japan (NASDA), Germany (ESOC), and France (CNES).

Operational voice is used by mission operations personnel to communicate verbal commands, status, marking conditions, and safety instructions. During a typical mission track, sequence operations personnel use the voice capability to communicate valuable mission parameters including spacecraft downlink state and health.

Real-time mission tracking parameters are also communicated between the Project Operations Centers (POCs), and the antenna facilities.

The traditional DSMS voice architecture includes a central Multi-Conference Digital Switch to connect distributed users. This architecture has traditionally required dedicated voice circuits or channels to carry the proprietary coded voice signals.

Voice over Internet Protocol (VOIP)

Voice can be encoded into Internet Protocol (IP) networks based on ITU H.323-series standards. It enables voice to be packetized into standard IP format to be carried on the IP-based ground network.

VoIP traffic stream of much smaller bandwidth, e.g. 8 kbps vs. normal 64 kbps per channel. In addition, experience has shown during a day, voice only uses bandwidth 3-6% of the time.

Voice has inherent quality demands and hence requires preferential treatment traveling through data network. Voice IP traffic is prioritized with highest priority over the DSMS routers for highest quality.There are other QoS techniques also deployed to ensure transmission of toll-quality voice - and data - on the same IP network.

Implementations

An initial operational voice pilot was implemented to support the Space Infrared Telescope Facility (SIRTF) development between Pasadena, CA, and Sunnyvale, CA across a T1 dedicated circuit in 1999. The VoIP was allocated 12 kbps of bandwidth, with the balance for TCP/IP data.

Based on this success, an operational system was installed to support two Project Operation Centers (POCs) for Mars Odyssey, at Arizona State University and University of Arizona.

Additional installations followed to support Cassini's Huygens Probe Operations Center (HPOC) in the European Space Operations Center in Darmstadt, Germany, and the Deep Space Communications Complex (DSCCs) in Goldstone CA.

VOIP is used in the NASDA DRTS-W support and is planned for ESOC INTEGRAL and Rosetta support.

The Madrid and Canberra DSCCs will transition to VOIP in FY03.

Results

The architecture has proven to be very robust and has resulted in significant cost savings. The architecture eliminates separate voice circuits and increases robustness because of redundancy built into the data network.

Two key architecture components are the dedicated circuits and voice-capable routers (those that enable prioritization of voice traffic). It may be possible to use frame relay services as a lower-cost carrier medium; we are investigating frame relay at the present time.

Application of VOIP is limited to WAN communications until the LAN can support priorities required for quality VOIP. We are planning an overhaul of our station LAN architecture to enable end-to-end VOIP.

Next Steps

The local networks at the DSCCs will transition to a type able to support VOIP starting in FY03.

AppropriateVOIP multichannel end instruments at DSCCs (with Ethernet interfaces rather than 4-wire interfaces) are under development.

The last step, which will complete the transition will be to deploy an IP-based central switch. This is not envisioned until the FY05 time period.